

MEMORANDUM FOR: Distribution

FROM: /s/ W/OPS2 - Douglas F. Hess (August 31, 2004)

SUBJECT: National Digital Forecast Database (NDFD) Central Server System (CSS) Test Report, August 2004

The attached report describes the results for the National Digital Forecast Database (NDFD) Central Server System (CSS) Operational Acceptance Test (OAT) conducted from May 18 to June 22, 2004. The OAT evaluated the performance of the NDFD CSS and the communications in receiving and processing the Weather Forecast Office (WFO) files and delivering the mosaic products to the public by storing them onto the NWS Telecommunications Gateway (NWSTG).

The OAT demonstrated partial readiness for the system to become operational. The CSS performed almost flawlessly in receiving and generating its products. However, the timeliness for disseminating the products failed to meet the success criteria consistently. The Field Systems Operations Center recommends implementation be delayed until the deficiencies are corrected.

Mary Buckingham, W/OPS24, was the OAT director. Questions or comments should be directed to Mary by e-mail at [Mary.Buckingham@noaa.gov](mailto:Mary.Buckingham@noaa.gov), facsimile 301-713-0912, or telephone 301-713-0326 x137.

Attachment

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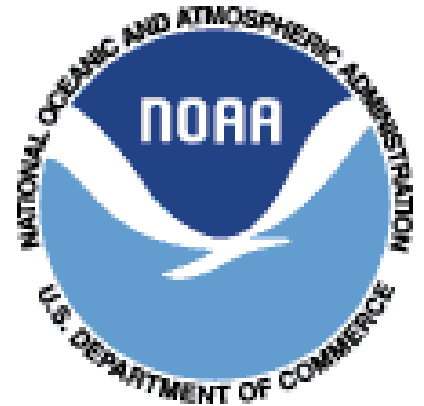
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NATIONAL WEATHER SERVICE



# **National Digital Forecast Database (NDFD) Central Server System (CSS) Test Report**

**August 2004**

**U.S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
National Weather Service/Office of Operational Systems  
Field Systems Operations Center/Test and Evaluation Branch**



# Operational Acceptance Test (OAT) Report for the National Digital Forecast Database (NDFD) Central Server System (CSS)

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## 1. Introduction

An Operational Acceptance Test (OAT) of the National Digital Forecast Database (NDFD) Central Server System (CSS) was conducted between May 18 and June 22 2004.

The OAT measured the performance of the NDFD CSS and the communications in receiving and processing the Weather Forecast Office (WFO) files and delivering the mosaic products to the public by storing them onto the NWS Telecommunications Gateway (NWSTG).

## 2. Recommendations

Based on the results of the OAT described in this report, these recommendations should be undertaken to improve overall system performance and reliability. The NDFD CSS should be further developed to meet the required timeliness. The Field Systems Operations Center recommends implementation be delayed until the deficiencies are corrected. Among the approaches suggested to address the timeliness are:

- a. Pursue the engineering work to determine whether replacing the current NDFD CSS hardware with newer and faster hardware and disks yields significant improvements. The system appears to be I/O bound and might benefit by using more modern technology such as the “Ustore” device. Reducing the NDFD processing time by half would ensure most files get to the file transfer protocol (FTP) server within the required time.
- b. Pursue the engineering work to solve the hanging FTP processes problems or alternative transfer methods.
- c. The NWSTG should proceed with their redesign of the NWSTG that will address and improve the timeliness and reliability of moving the mosaic products through the NWSTG to the FTP server. However it is not expected to be complete until 2006. An overall assessment of NWSTG capacity to handle its overall load should be addressed to determine whether the systems are capable of reliably handling the throughput of data currently asked of it.
- d. Improve reliability of database start on failover.
- e. Improve customer call responsiveness to NDFD calls.

### 3. Purpose

The OAT purpose: *The OAT for the NDFD CSS will provide NWS management with measurements of system and communication performance and reliability, information about the operational and maintenance impact, and performance over a 30-day period.*

### 4. Success Criteria

#### a. WFO Grib2 File Transmission

1. 99.95% of WFO Grib2 files are received and stored into the NDFD CSS data base.
2. Grids arrive in time for the hourly mosaic generation. From x-1:46 to x:45, 99.95% WFO grids incorporated into the x hour mosaics.
3. WFO grids are updated as events require (WFO responsibility) and at least 1 time per day by 18Z (beyond the scope of this OAT). The mosaic products are fully generated (215 superheader files) for each hour for which at least one WFO transmitted new data.

#### b. Mosaic Official User Products

1. 99.95% of available WFO Grib files are inserted into the appropriate NDFD mosaic products and available on the NWSTG FTP Server once per hour by xx:01 each hour (unless no WFO sent an update). (*Note: The threshold criteria is once per hour by xx:10*).
2. Mosaic software uses most recent WFO data. The seventh day's forecast must change at 18Z within any 24 hour period.

#### c. Mosaic Official User Product Retention (Archival)

1. 100% retention of all mosaic products on the Netapps and tape backups with retention of the FTP server logs to provide proof of product dissemination.
2. Ability to retrieve any mosaic product on demand within 2 days of request.
3. All Mosaic Official User Products can be retained for at least 5 years.

### 5. OAT Objectives and Results

The following are the objectives of the NDFD OAT and the results of testing:

- a. Verify the NDFD receives and stores WFO grids with adequate timeliness and reliability.  
*Requirement:* 99.95% received at the NDFD server within 1 minute and are processed into the WFO data base in time for hourly mosaic generation.  
*Performance:*  
GribDecoder Segment: One product failed to store into the WFO data base in time for hourly mosaic generation (6/1/04, 12Z YGXM00GJT) in 30 days. (Overall performance: 201141 files successfully received and processed/201142 files sent from WFOs = 99.9995% reliability; exceeding the requirement.)  
AWIPS Segment: 99.97% of products sent from the WFOs were successfully received at the NDFD CSS. They took an average of 0.84 minutes (50.4 seconds) with a standard deviation of 2.42 minutes. This figure includes the Alaskan and Hawaii

products. The Alaska products far exceed an acceptable threshold for transmitting to the NDFD CSS but were not part of this OAT. A total of 457,490 products were sent across AWIPS to the NDFD CSS during 30 days. The 43.96% of them were detected as changed files and were sent for processing.

**Conclusion: This requirement was fully met for the CONUS WFOs.**

- b. Verify the NDFD creates the NDFD mosaic grids and transmits them to the NWSTG FTP server with adequate timeliness and reliability.

*Requirement:* 99.95% of available WFO Grib files are inserted into the appropriate NDFD mosaic products and available on the NWSTG FTP Server once per hour by xx:01 each hour (unless no WFO sent an update). (*Note: The threshold criteria is once per hour by xx:10*). The Requirement allows 15 minutes to deliver the products by the top of each hour.

*Performance:*

Reliability: Over the 30 days, 154,800 mosaic product files were created (100% of the requirement). 153,291 were successfully received at the NWSTG FTP server yielding 99.03% success rate (1509 files lost). (215 mosaic files are supposed to be created per hour.) The lost files occurred on 3 days: 5/20/04 95.68% (223 files lost); 6/4/04 79.24% (1071 files lost); 6/14/04 95.83% (215 files lost). On each of these days, the lost files were caused by problems in the NWSTG.

Timeliness: The average time it took (over the 30 days) to finish storing the mosaic products on the NWSTG FTP Server each hour was 15.11 minutes with the longest average taking 26.25 minutes. The hours when the mosaics exceeded the requirement using the averaged last file were 04Z, 09-12Z, 14-18Z, and 21Z. 56% of the mosaic runs each hour completed the transfer to the NWSTG FTP server within 15 minutes (by the top of the hour); 32% took 20 minutes (5 after); 9% took 25 minutes (10 after); and 3% took more than 25 minutes. See the Attachment, *Percent of Time All Mosaics Are at FTP Server Each Hour* chart for the probability of the times the mosaics arrive each hour.

**Conclusion:**

**Reliability:**

- The NDFD CSS performed flawlessly in producing the required number of mosaic files.
- Three NWSTG failures caused the reliability to drop below the requirement.

**Timeliness:**

- Eight hours during the day consistently take longer than the required 15 minutes to arrive at the FTP server (9-11Z, 15-18Z, 21Z). The other hours cited above are near the 15 minute threshold. The remaining hours finish before the time requirement of the top of the hour.
- The large amounts of incoming data from the WFOs directly affects the time it takes the NDFD CSS to process the mosaic files.
- The FTP transfers from the NDFD CSS to the NWSTG take from nearly instantaneous to nearly nine minutes (excluding the three NWSTG failures) and averages 0.87 minute. The NDFD CSS periodically holds some of the files for a few minutes before sending them for unknown reasons.
- Moving the files from the Weather Data Event (WDE) server in the NWSTG to the FTP server takes from 0.1 minute to over 24 minutes and averages 1.83 minutes.

- c. Verify the NDFD failover processes function correctly with no loss of data.

*Requirement:* Upon system failure, the surviving server automatically starts the system processes and NDFD CSS applications with no loss of data.

*Performance:*

PX1 failure did not automatically start the Informix database on PX2. The cluster package did otherwise start on PX2.

PX2 failure resulted in automatic start of all processes on PX1. (Successful)

**Conclusion: The failover test was not fully successful. More work needs to be done to ensure reliable automatic failover for a PX1 failure.**

- d. Verify recovery from degraded operations does not interrupt NDFD data.

*Requirement:* Restoring the system to full operations causes no loss of data.

*Performance:* Attempts to fix the failover problem resulted in a loss of 2.5% of the incoming WFO products for the day. Hourly losses ranged from 0.82% to 42.49% losses over 7 hours. No mosaic products were lost due to the fix efforts.

**Conclusion: Data loss due to recovery is uncertain. The resulting data loss was most likely more excessive than it would have been if only corrective action had been taken to get the system running rather than attempts to fix the underlying problem. Further testing should be done to determine realistic expectations of recovery.**

- e. Verify the NCF (or TOC) is able to detect NDFD and communication failure conditions and respond according to the support required of them (restore operations within one hour of failure).

*Requirement:* Prompt and appropriate action in determining a failure occurred within 10 minutes of failure.

*Performance:* During the failure tests, the NCF did not call to ask about the system failing to start properly.

**Conclusion: The NCF failed to respond to a system outage. More testing should be done to determine NCF responsiveness to NDFD CSS system problems.**

- f. Verify the NDFD correctly creates mosaics from all available WFO data. *The OAT will not verify the scientifically correct functioning of the mosaic creation.*

*Requirement:* All WFO files updated and available on the NDFD CSS since the last run of the mosaic generation are incorporated into the appropriate mosaic products.

*Performance:* No tools were available to measure this requirement. However, no complaints of missing WFO data were received during the OAT.

**Conclusion: There is no reason to believe this a problem area but efforts should be made to ensure the programs are actually performing correctly.**

- g. Verify support capability for user complaints. (TG support desk; refer NDFD CSS problems to NCF; no backup system available)

*Requirement:* Prompt and accurate response to customer query within 2 days.

Appropriate handoff of question to NCF or WFO for answer.

*Performance:* A meteorological question to the NWSTG customer care number resulted in a voicemail contact. A question was left on the voicemail with the work

telephone number as a contact. After 2 business days, no return call was made.

**Conclusion: The response for a customer query did not meet the requirement. The response should be improved for NDFD calls to the line.**

- h. Verify mosaic data are retained for 5 years in a manner preventing alteration for archival and providing proof of product dissemination.

*Requirement:* 100% of products are successfully stored. Time constraints are unspecified but within 2 months is a reasonable time frame.

*Performance:* The products are stored upon creation to a Netapps device then written to a write-once CD-ROM and stored. Concurrently, NCDC has captured the data from the NWSTG after it has written to the FTP server. NCDC is not yet ready to support full retention and delivery requirements.

**Conclusion: The interim strategy of storing the data on write once CD-ROMs is adequate for storage of the data for 5 years under the CD-ROM manufacturers storage requirements along with the FTP server log which shows the products actually disseminated. The NWS should proceed with actions to store and retrieve the data permanently at the NCDC and test the process.**

- i. Verify the archived data can be reliably retrieved from all backups and the permanent archive media upon demand. Time constraints are unspecified but within 2 days is a reasonable time frame.

*Requirement:* Ability to retrieve any mosaic product on demand within 2 days of request.

*Performance:* This test was not performed.

**Conclusion: This test should be performed once the NCDC is ready to support full data retention.**

## 6. Conclusions

The NDFD CSS performed as well as it could with the current hardware and configuration. However, it did not fully meet its required performance.

The timeliness of the storage of the NDFD mosaic products onto the NWSTG FTP Server does not meet the stated requirement consistently for 6-7 hours per day. Steps should be taken to improve the timeliness, especially in NDFD CSS system processing time and shortening the FTP transfer time between the NDFD CSS and the NWSTG. The differences when the data are available on the FTP server varies considerably from hour to hour (average from about 5 minutes before the hour to 11 minutes after; some days are much longer). NWSTG problems caused long delays (i.e., hours) and product loss nearly every week .

The mosaic creation processes in the NDFD CSS performed flawlessly.

The NDFD ingest of WFO products performed very well.

The failover does not reliably occur automatically for unknown reasons.



Over the long term, the high availability requirements cannot be met without a backup system in case of catastrophic failure of both servers in the CSS.

The data retention portion of the test for ensuring the products meet the legal retention requirements with NCDC was not completed and not fully in place at the time of the test.

The NWSTG periodically delayed the transmission of the NDFD products during this test along with frequent (10-11Z 5/20, 12Z 5/26, 15-22Z 6/4, 20Z 6/14; see Attachment for details) system failure problems. NWSTG is actively implementing replacement of a redesigned system scheduled for completion in 18 to 24 months. (It is recognized that a 30-day test does not give a completely reliable statistical sample of actual communication system performance. A much longer sample is required to give a firm result.)

The developers have additional strategies to improve the performance of the system and these should also be pursued in addition to the recommended improvements to improve the overall system performance and reliability in this OAT. The initial operating requirements of the system do not fully meet the needed products under discussion in the NWS. Adding to the requirements will require much faster processing and a more robust system than the current one.

## Attachment: Test Results

### NWSTG System Failures

There were 4 periods when the NWSTG experienced a failure to transmit the mosaic products in a timely manner or lost them. These were:

- 10-11Z 5/20: NWSTG upgraded a server and encountered unforeseen problems
- 12Z 5/26: On Wednesday, May 26, 2004 at approximately 1051 UTC, a filesystem on the NWSTG core switching system (the Weather Data Exchange (WDE) server) reached 100% utilization. Response by a programmer to correct the filesystem problem by restarting software was successful but the middleware software supporting movement of data between this system and others did not restart correctly
- 15-22Z 6/4: There was a failure of one of the communication cards in the NWSTG internal router (SOC1) that required a replacement of the card and a router restart. This failure had the effect of severing communication between the NCF and the FTP gateway and between the FTP gateway and the WDE system.
- 20Z 6/14: One hour outage or log loss for unknown reason.

### NDFD Mosaic Product Data

The charts show the time it takes the NDFD mosaic products to begin their creation process at 45 minutes after each hour and transmit to each server until they arrive at the dissemination point NWSTG FTP server. The log collection points are identified as T1 through T6 and are illustrated in Figure 1:

$T_1$	Time Mosaic generator starts (clock time at x:45).
$T_2$	Time Mosaic generator begins to create mosaic grids and transmit file opens.
$T_3$	Time Mosaic transmit file closes and is sent to the NWSTG pftpgate.
$T_4$	Time Mosaic grid transmit file arrives at the NWSTG pftpgate.
$T_5$	Time Mosaic grids arrive in the NWSTG WDE.
$T_6$	Time Mosaic grids are stored on the NWSTG FTP server.

The times are shown in minutes beginning from the start of the mosaic generation time at 45 minutes after each hour. The success criteria require the mosaics be disseminated by the top of each hour.

The chart, *Average Frequency (percent of hours) of Time Mosaics Arrive at FTP Server*, shows the percentage of hours over the entire data period the mosaic products arrived at the FTP server in 4 time bands: The blue is the percent of hours (the first product, Min; average of all the products or mid point; and the last product, Max) the products arrived by the top of the hour or 15 minutes after the mosaic generation process is started at :45. The red is the percent of hours the products arrived by 5 minutes after the hour, yellow is the percent of hours the products arrived by 10 minutes after the hour, and pale green is the percent of hours the products arrived more than 10 minutes after the hour.

## NDFD Ingest

The last two graphs show the WFO data ingest processing from the filter after the NDFD message handler to the data storage into the Informix data base.

In Figure 1, the log collection points for the Ingest data are:

Log Point	Data Collection Points Identified in Figure 1
$t_1$	Time NDFD WFO Grib2 Products Leave the WFO (x.400 log)
$t_2$	Time NDFD WFO Grib2 Products arrive at the NDFD CSS Message Handler
$t_3$	Time NDFD WFO Grib2 Products are decoded and stored into the WFO Grid database.

Additional data analysis of the performance of ht NDFD CSS and communications paths is available upon request.

## NDFD CSS Data Flow

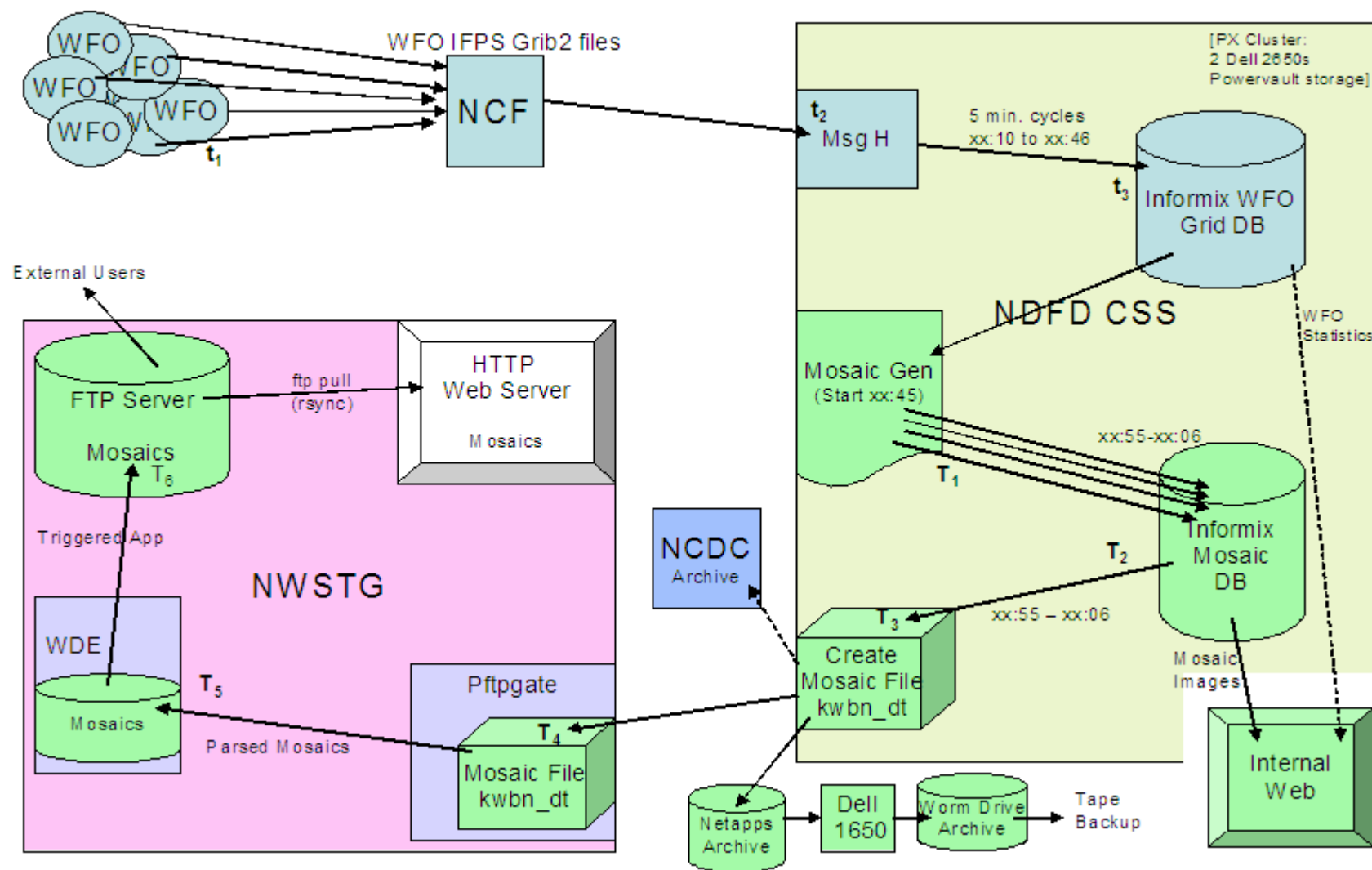
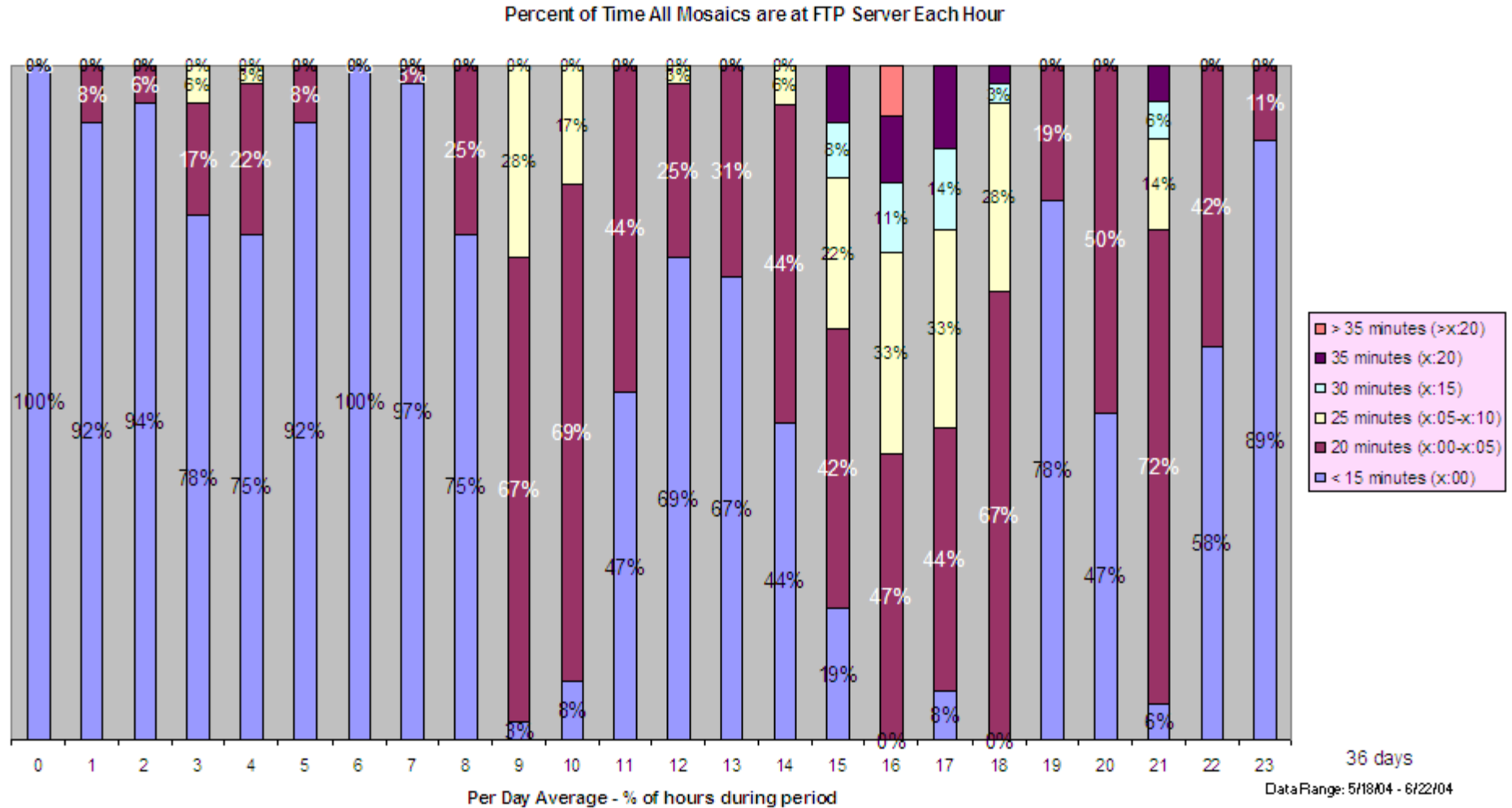


Figure 1. NDFD Data Flow



This chart shows the probability all the mosaic products are at the NWSTG FTP server for each hour.

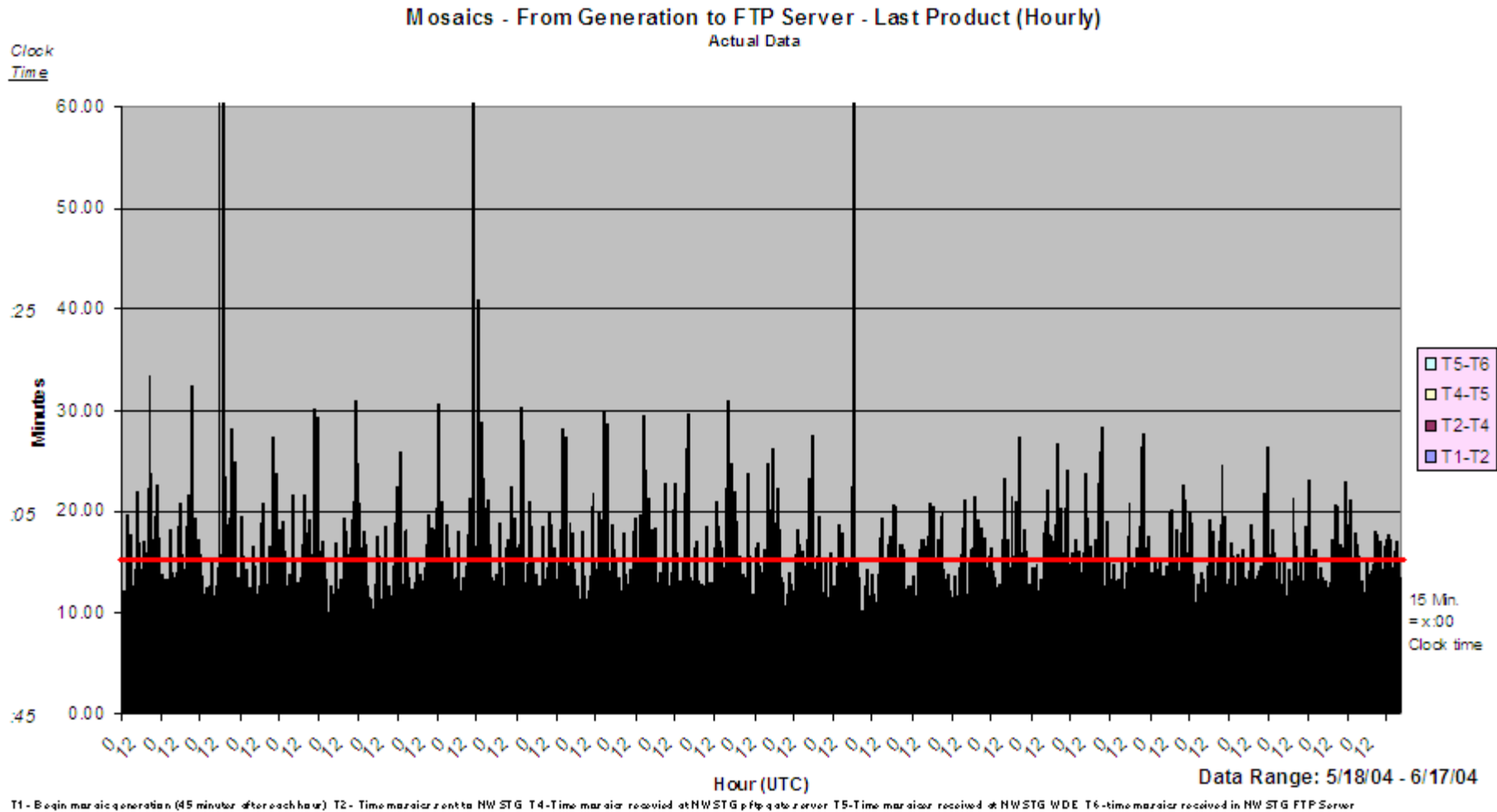
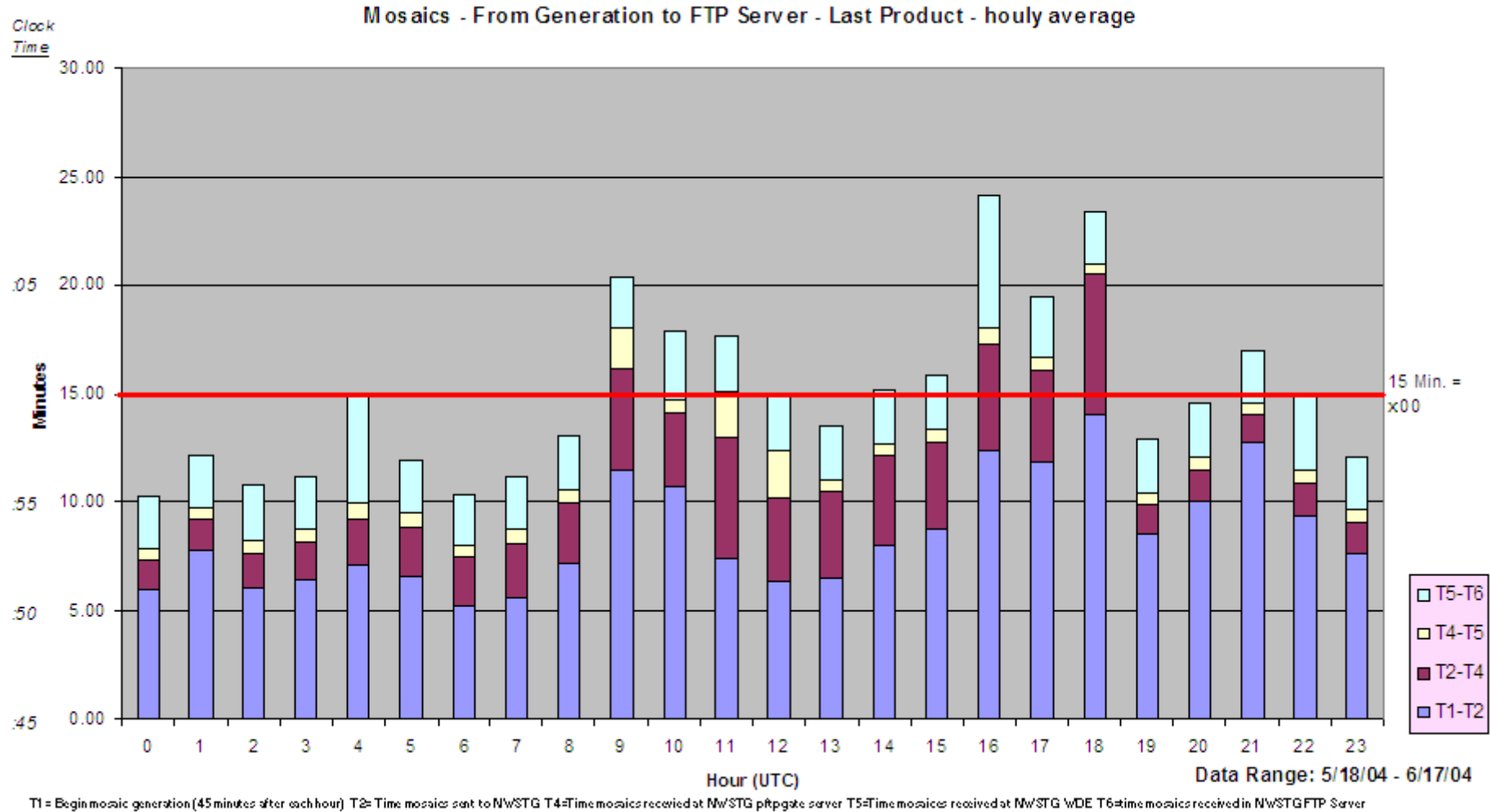
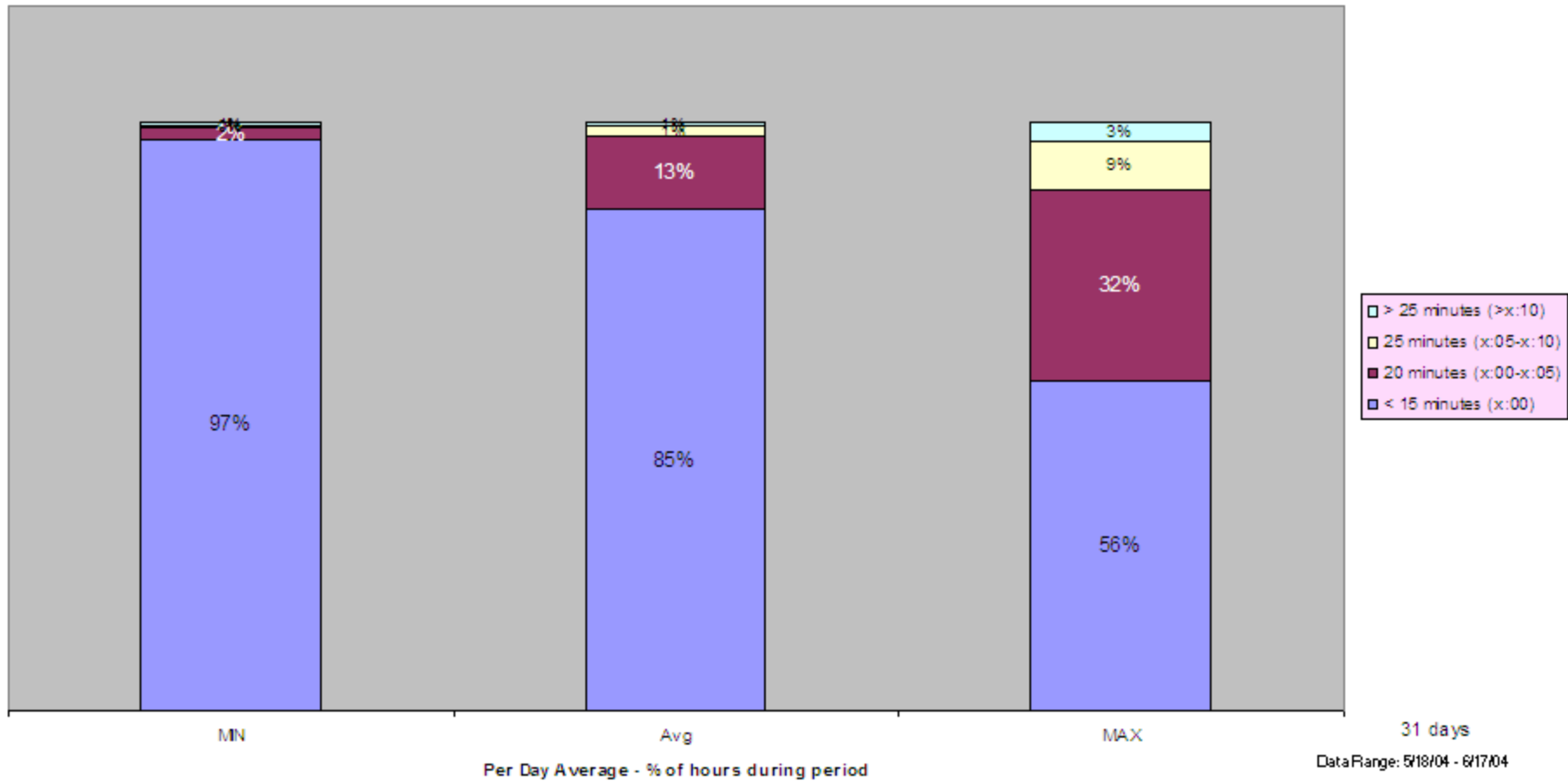


Chart tracks the hourly arrival of the mosaic products at the NWSTG FTP server over the period of the OAT. The 3 lines exceeding 60 minutes are three NWSTG system failures (see the *NWSTG System Failures* section at the beginning of this Attachment). Products failing to arrive within an hour of the start of the mosaic generation process at 45 minutes after the hour become difficult to track. Therefore they are counted as lost.



This chart shows the average for each hour the mosaic products completed transmitting to the NwSTG FTP server and the average for how long each step took.

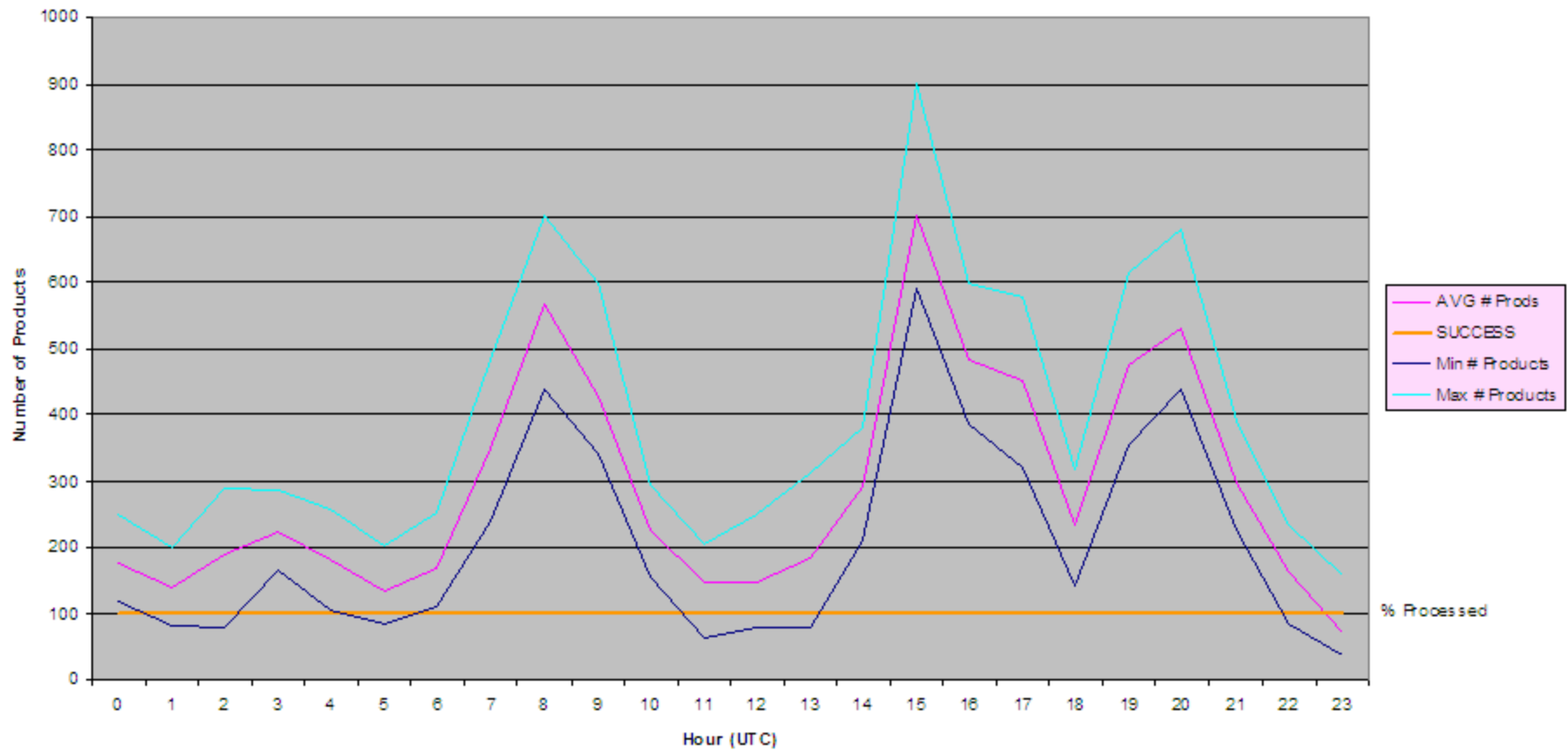
Average Frequency (percent of hours) of Time Mosaics Arrive at FTP Server



This chart shows the percent of time the mosaic products were stored on the NWSFG FTP server by the target time of the top of the hour or 15 minutes after the mosaic generation started, by 5 after the hour, by 10 after the hour, and later than 10 after the hour. The Max column shows when the mosaics finished each hour. The avg column shows the approximate mid point, and the min column shows the beginning of the mosaic generation and transmission. Each hour, 215 files were sent to the FTP server.

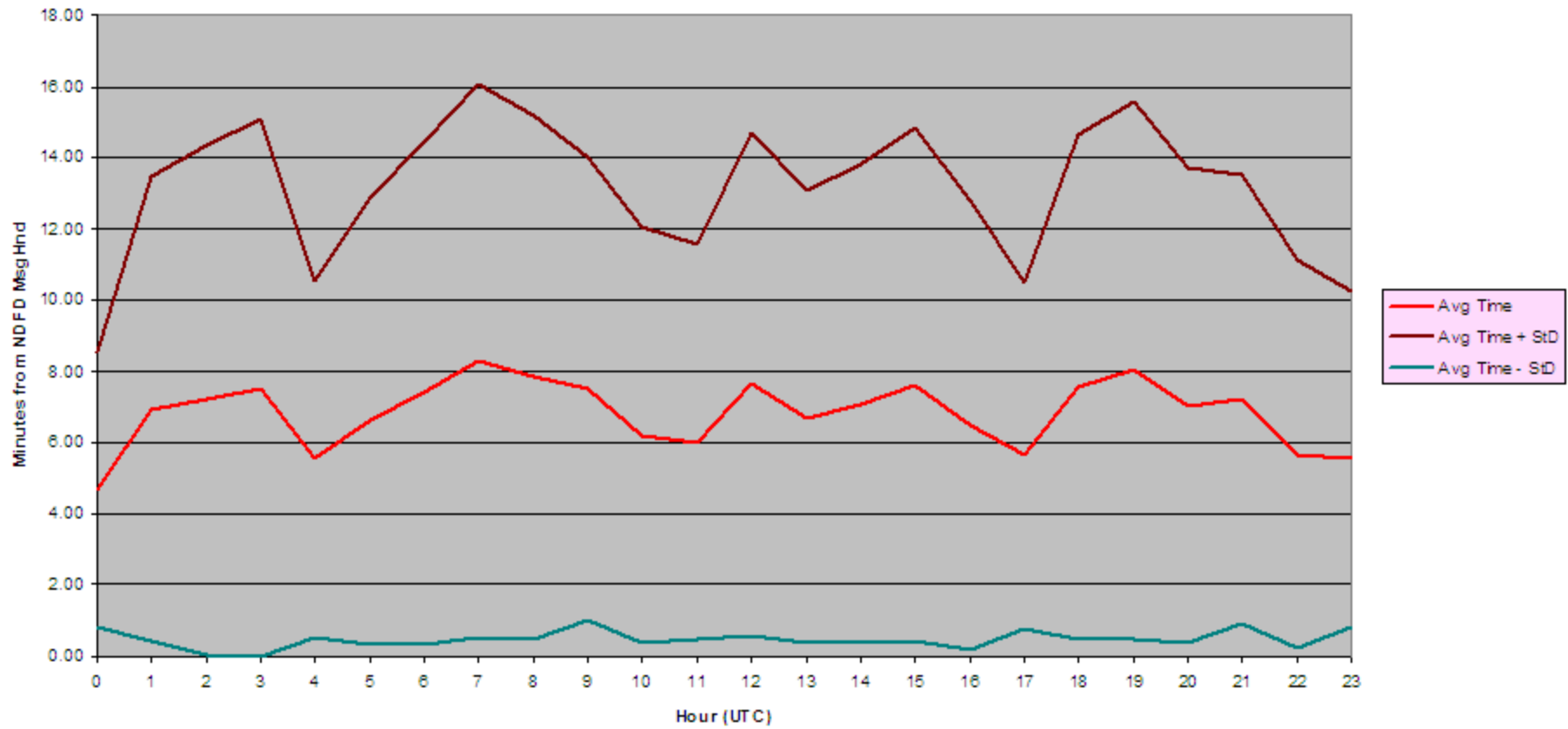


WFO File GribDecoder  
Products Ingested



This chart shows the average number of new WFO files ingested into the NDFD CSS WFO data base each hour and the reliability (100%).

WFO File GribDecoder  
Average Time to Process with  $\pm 1$  Standard Deviation  
From NDFD Message Handler to WFO Database



This chart shows the average time each hour it took the NDFD CSS to decode and store the WFO files into the WFO database.